



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
17.09.1997 Bulletin 1997/38

(51) Int. Cl.⁶: **H01F 7/08, H01F 7/16**

(21) Application number: **97103754.4**

(22) Date of filing: **06.03.1997**

(84) Designated Contracting States:
DE FR GB IT

(30) Priority: **11.03.1996 JP 53149/96**
20.12.1996 JP 341729/96

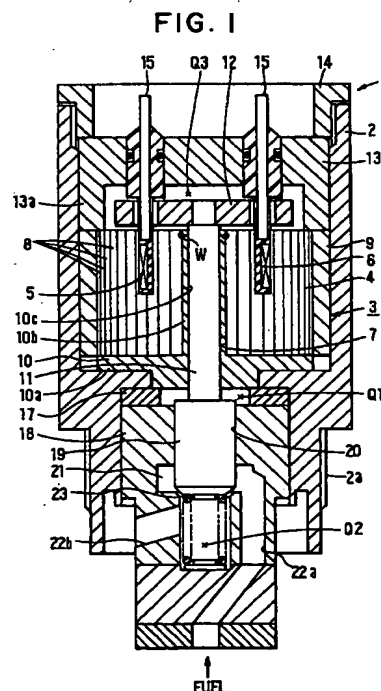
(71) Applicants:
• **DENSO CORPORATION**
Kariya-City Aichi-Pref. 448 (JP)
• **NIPPON SOKEN, INC.**
Nishio-City Aichi-Pref. 445 (JP)

(72) Inventors:
• **Enomoto, Shigeiku,**
c/o Nippon Soken, Inc.
Nishio-city, Aichi-pref (JP)
• **Gotoh, Moriyasu,**
c/o Nippon Soken Inc.
Nishio-city, Aichi-pref (JP)
• **Takasu, Koji,**
c/o Nippon Soken Inc.
Nishio-city, Aichi-pref (JP)

(74) Representative: **KUHNEN, WACKER & PARTNER**
Alois-Steinecker-Strasse 22
85354 Freising (DE)

(54) **Electromagnetic device with stator displacement regulation**

(57) A stator (4) is constructed by spirally disposing around the central axis thereof a plurality of magnetic plates (8) each having a uniform thickness and being bent in a curved shape. A support body (10) is so assembled to the stator as to abut its bottom face and a through hole (7). The support body has a disk part (10a) having an outer diameter generally corresponding to that of the stator and a cylindrical part (10b) extending upwardly from the central part of the disk part. The top end part of the cylindrical part is fixedly joined to the stator by the laser welding. A push rod (11) coupled with an armature (12) is disposed slidably in a hole (10c) of the support body. The bottom face of a cap housing (13) abuts the peripheral part of the top face of the stator to press the peripheral part from the upperside.





European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 97 10 3754

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A,D	PATENT ABSTRACTS OF JAPAN vol. 017, no. 241 (E-1364), 14 May 1993 & JP 04 365305 A (NIPPONDENSO CO LTD), 17 December 1992, * abstract *	1	H01F7/08 H01F7/16
A	FR 1 528 470 A (SIEMENS)		
A	US 3 036 247 A (KOONTZ-WAGNER ELECTRIC COMPANY)		
A,D	PATENT ABSTRACTS OF JAPAN vol. 015, no. 329 (M-1149), 21 August 1991 & JP 03 125086 A (NIPPONDENSO CO LTD), 28 May 1991, * abstract *		
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			H01F
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 9 June 1997	Examiner Vanhulle, R
<p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document</p> <p>T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document</p>			

EPO FORM 150 (01.92) (P0001)

FIG. 16(a)
PRIOR ART

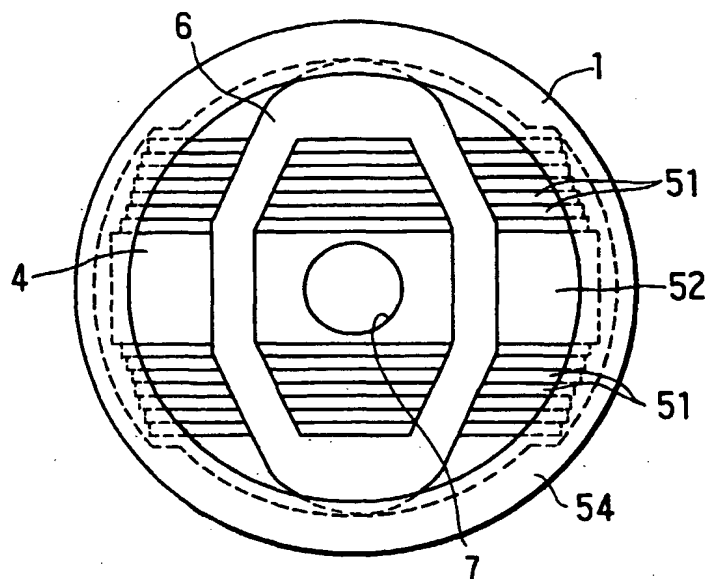


FIG. 16(b)
PRIOR ART

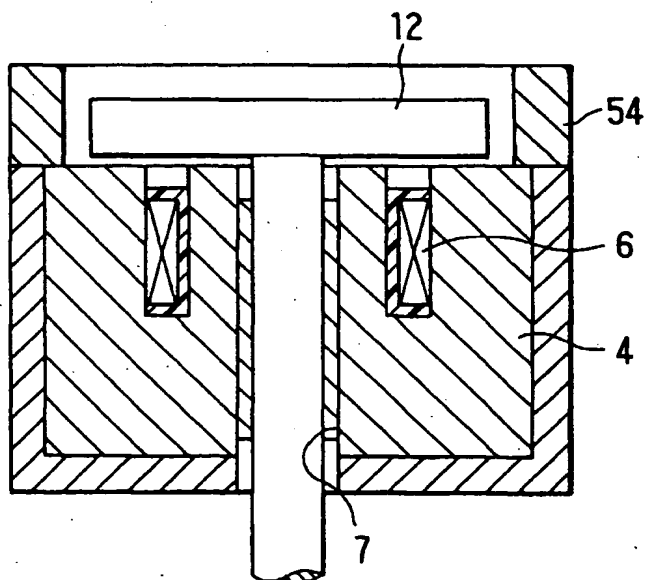


FIG. 14
PRIOR ART

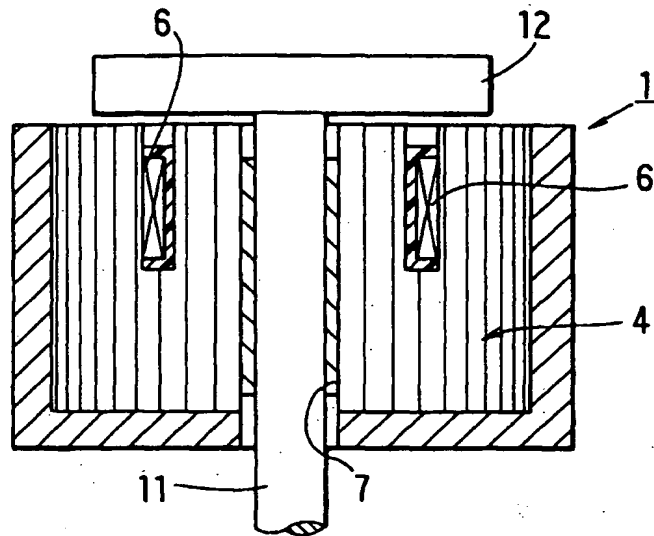


FIG. 15
PRIOR ART

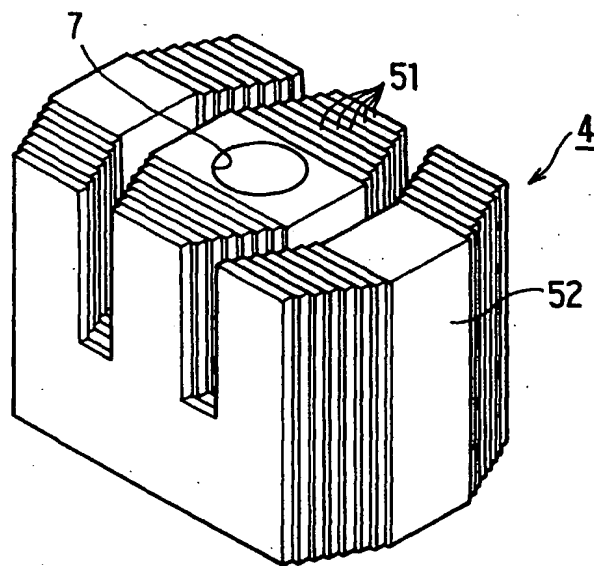


FIG. 13

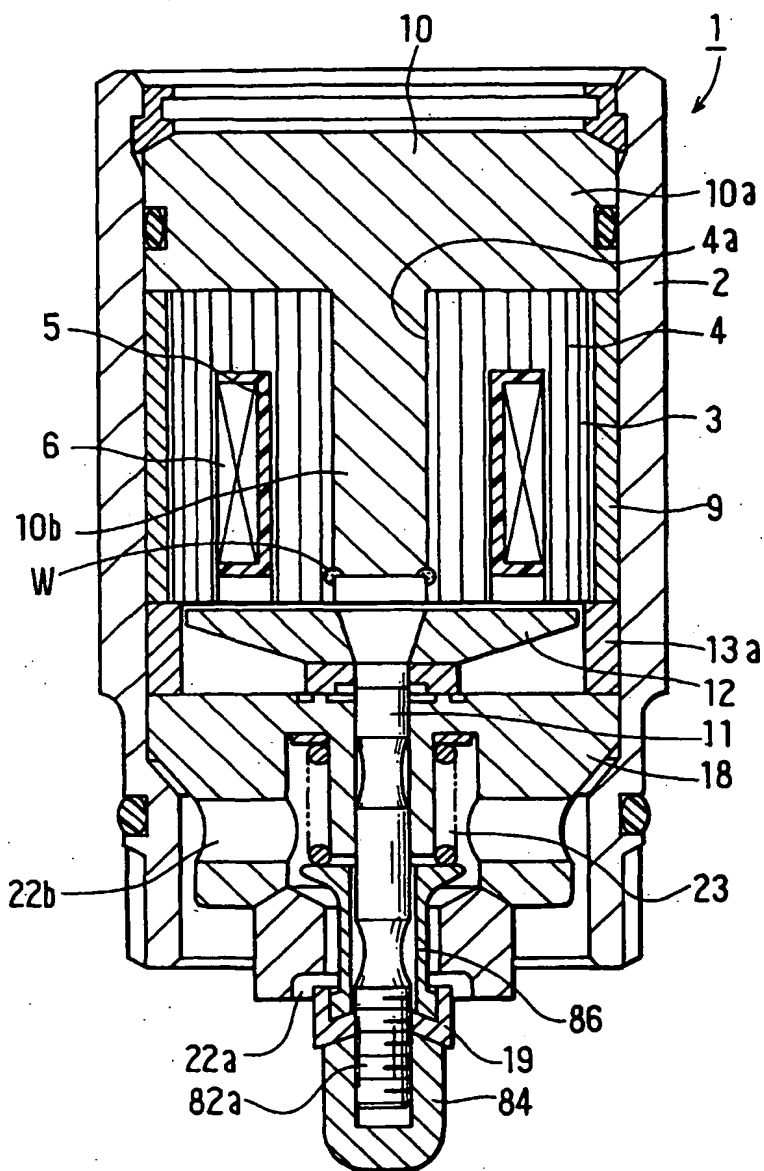


FIG. 11

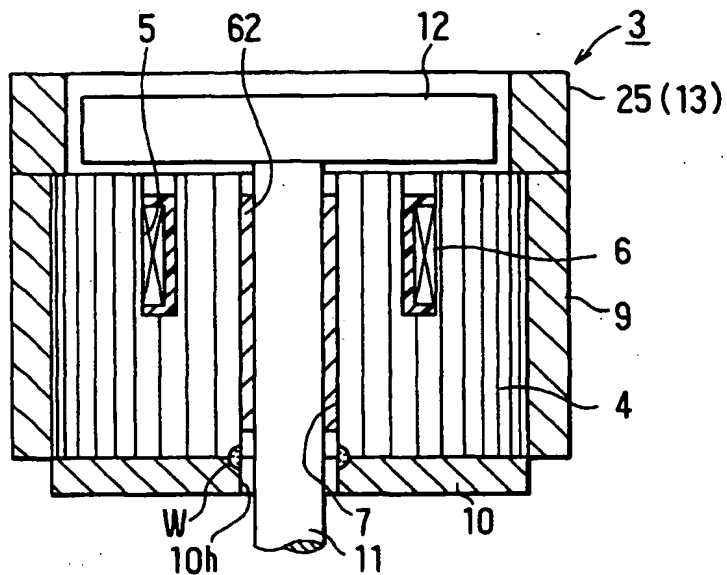


FIG. 12

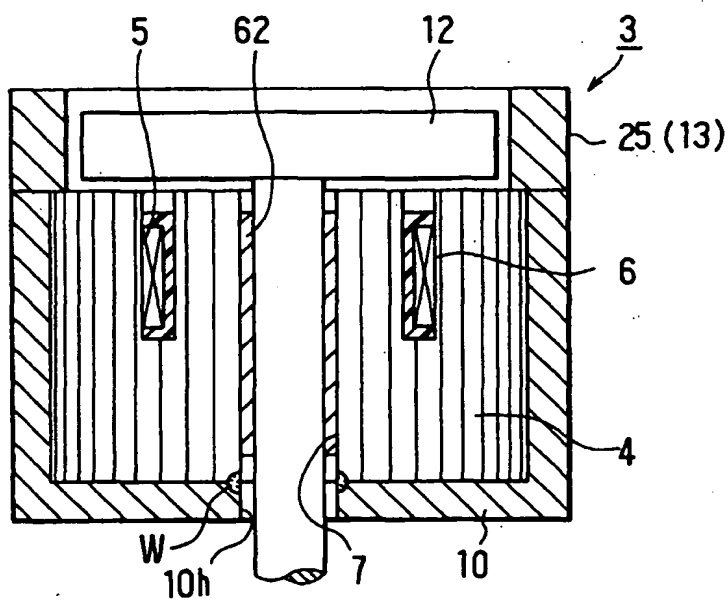


FIG. 9

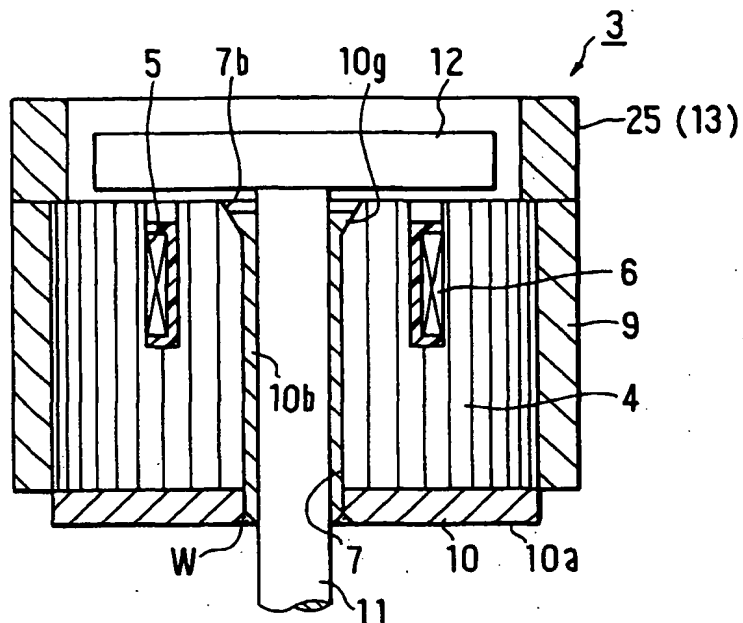


FIG. 10(a)

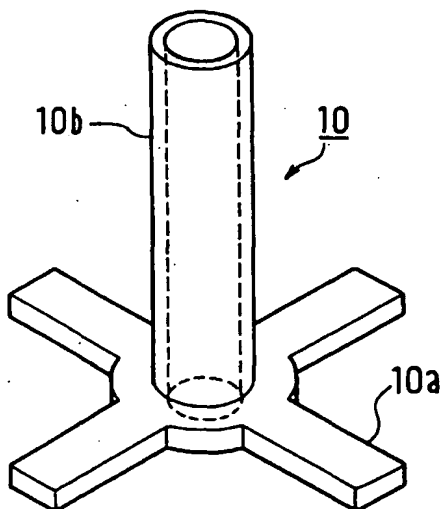


FIG. 10(b)

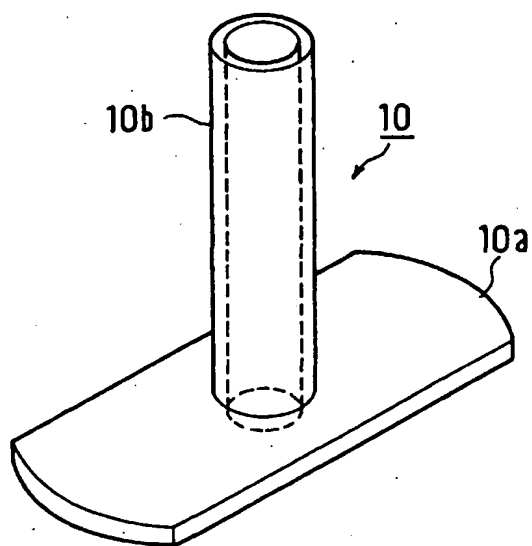


FIG. 7

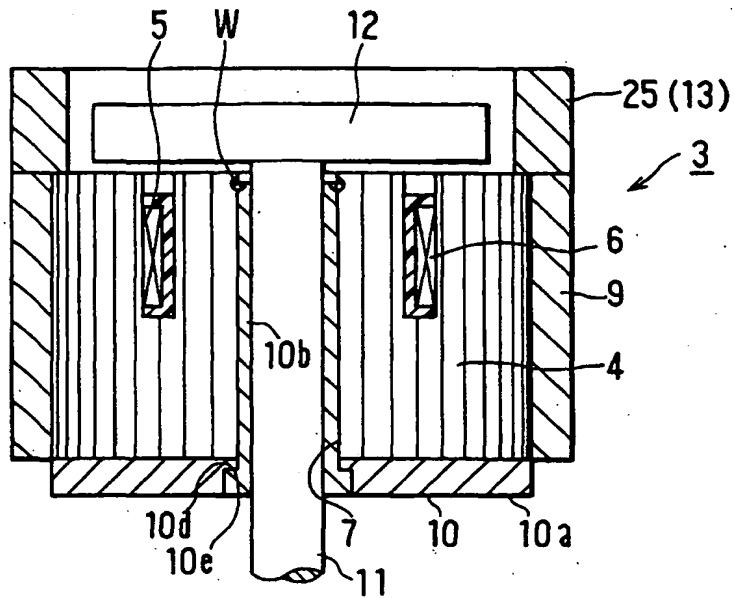


FIG. 8

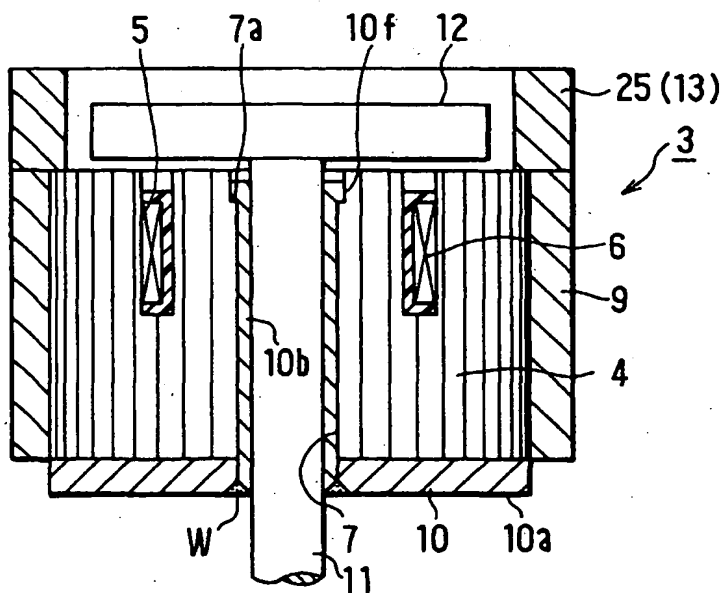


FIG. 5

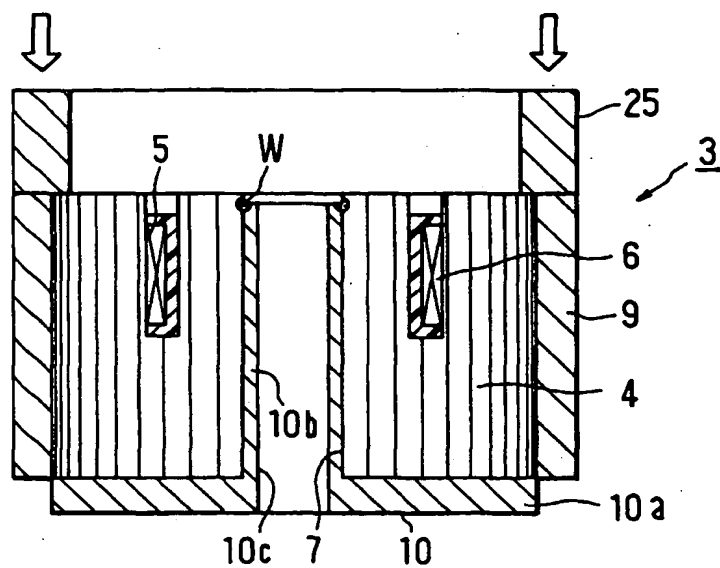


FIG. 6

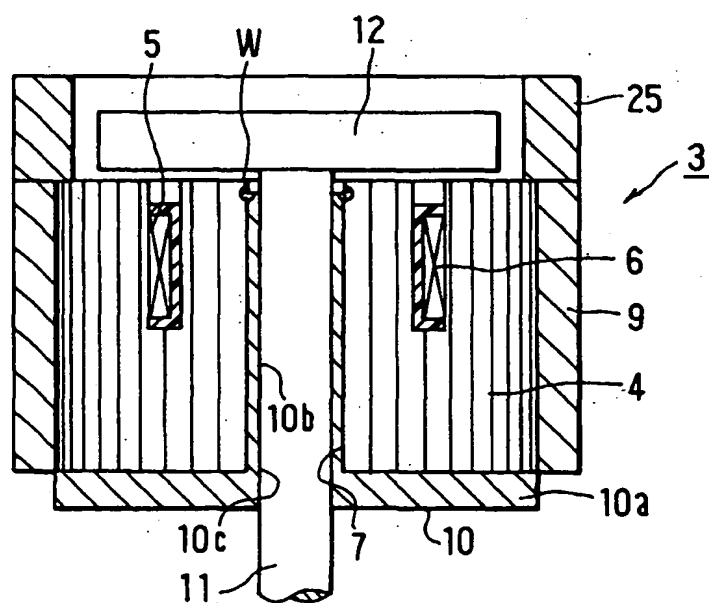


FIG. 4

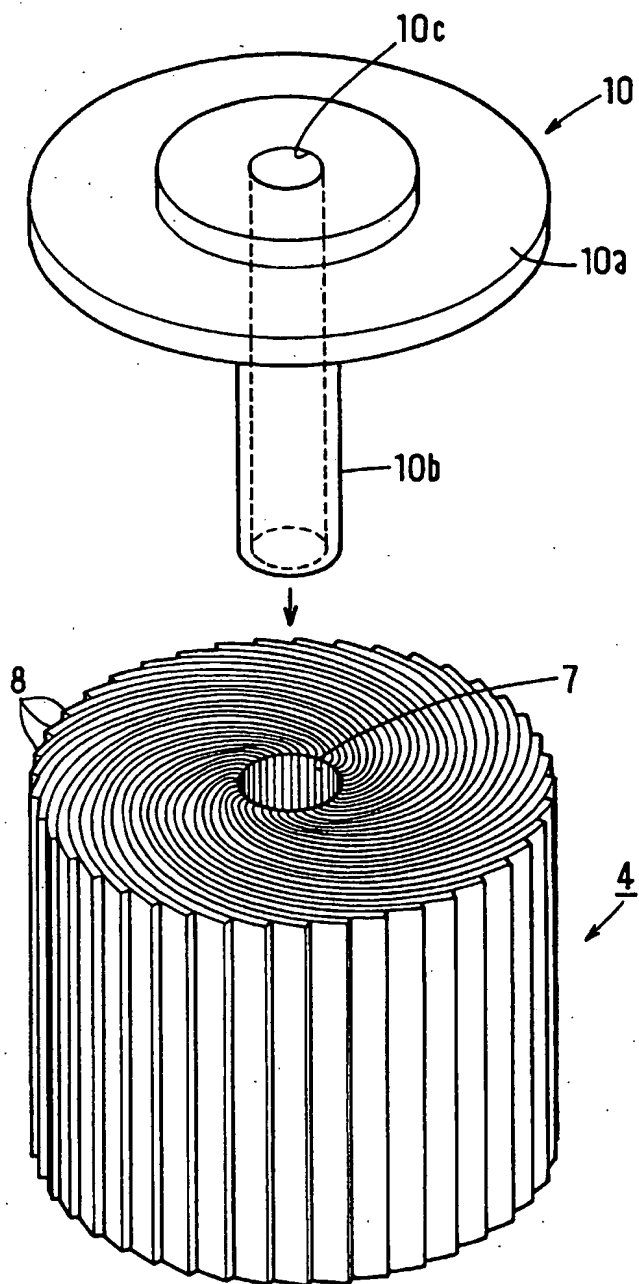


FIG. 2

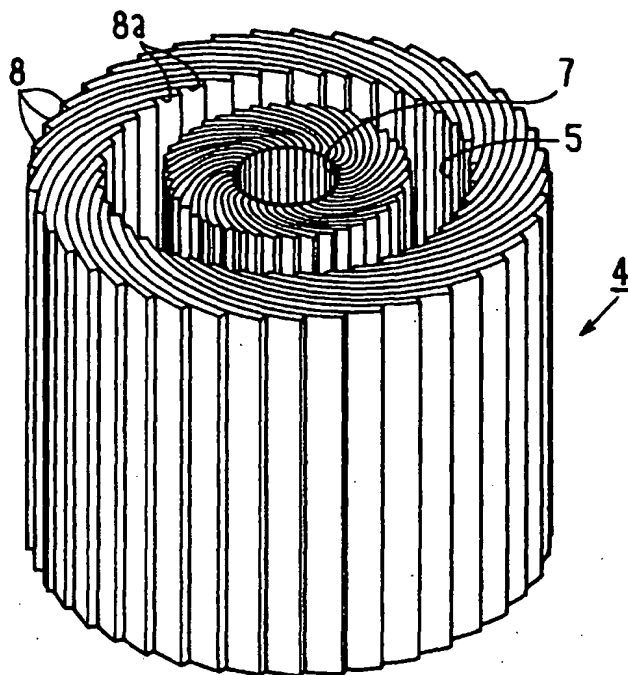


FIG. 3

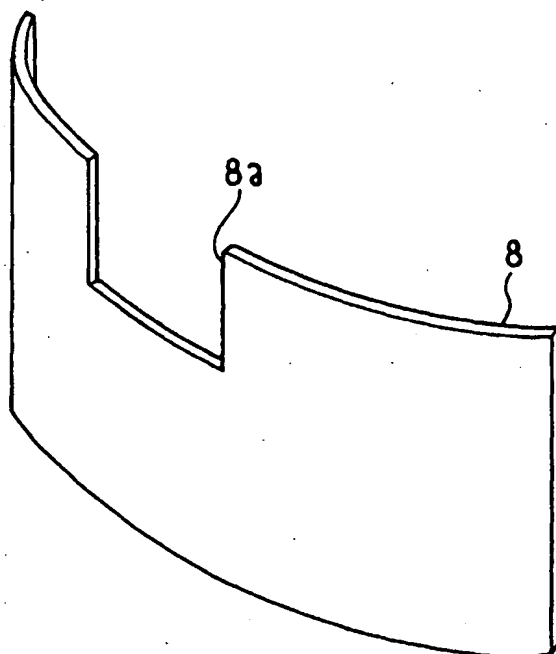
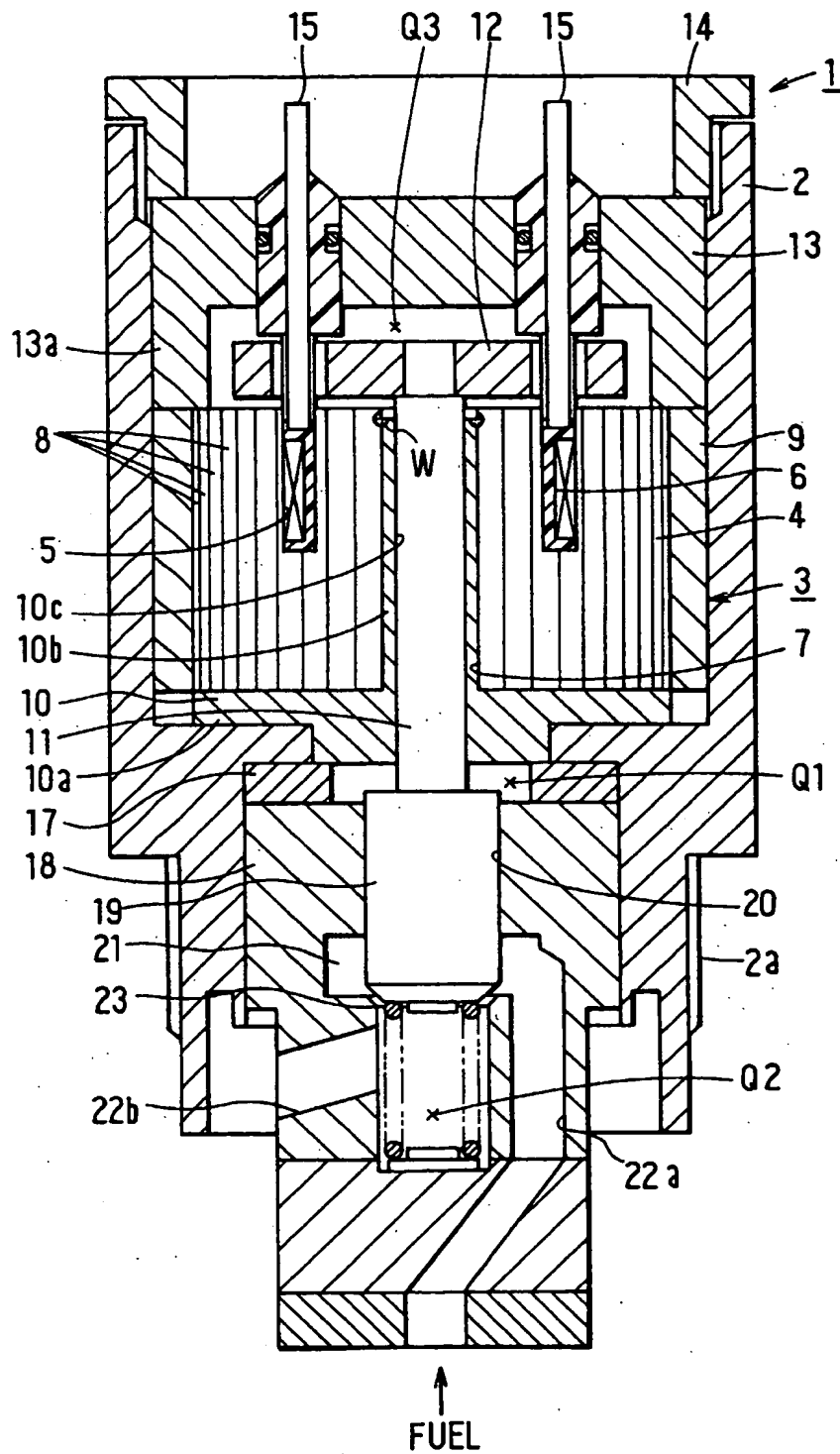


FIG. 1



of a magnetic pole face of the stator opposing the armature; and

the first position regulating member has a position regulating part (10b - 10h, W) for regulating, in a position from the abutment part to a through hole at a central part of the stator, the axial position of the magnetic plates.

4. An electromagnetic device according to claim 3, wherein:

the position regulating part has a cylindrical part (10b, W) welded to a radially inner end face of the magnetic plates within the through hole of the stator.

5. An electromagnetic device according to claim 3, wherein:

the position regulating part has an engagement part (10d - 10g) engaged with a radially end face of the magnetic plates within the through hole of the stator.

6. An electromagnetic device according to claim 1 or 2, wherein:

the first position regulating member is in abutment with an opposite face of a magnetic pole face opposing an armature and is welded to the magnetic plates within a through hole at a central part of the stator.

35

40

45

50

55

integrated. At the time of welding by the laser welder, for instance, the top peripheral face part of the stator 4 and the top face of the ring 9 are pressed by the jig 25 which corresponds to the cap housing 13 of the electromagnetic device 1.

As shown in Fig. 12, on the contrary, the support body 10 may be constructed in a cup shape by integrating the support body 10 and the ring 9 shown in Fig. 1. The support body 10 is formed at the central part thereof the hole 10h having the same diameter as the through hole 7 of the stator 4. The boundary between the through hole 7 and the hole 10h is welded by the laser welder as indicated by W with the bottom face of the stator 4 and the support body 10 being in contact with each other.

According to the construction shown in Figs. 11 and 12, the similar advantages can be provided as in each of the foregoing embodiments. That is, because all the radially inner ends of the magnetic plates 8 which form the stator 4 are welded to the support body 10 at the welded part W, no such disadvantages as the rising and displacement of the stator 4 will not occur.

(Seventh embodiment)

In Fig. 13, the electromagnetic device 1 is constructed as a normally open valve for fuel injection. The stator assembly 3 which is in spirally stacked construction as in the foregoing embodiments is disposed in the solenoid housing 2. That is, the stator assembly 3 is constructed generally by the stator 4 comprising a number of magnetic plates and having the through hole 4a at the radial center and by the ring 9 fitted around the outer periphery of the stator 4. The coil 6 is wound in the annular groove 6 of the stator 4. The support body 10 is mounted as the first position regulating member on the upperside of the stator 4 and has the disk-like base part 10a abutting the stator top end and a cylindrical body 10b inserted into the through hole 4a of the stator 4. The bottom end of the cylindrical body 10b is welded by the laser welding as indicated by W to all the spirally stacked magnetic plates of the stator 4. The bottom peripheral part of the stator 4 is position-regulated by a ring 13a as the second position regulating member.

On the other hand, the armature 12 is disposed underside the stator 4 to face the magnetic pole face of the stator 4 and is attached at the central part thereof with the push rod 11 which extends downwardly from the armature 12 through the valve housing 18. A male thread 82a is formed on the lower side of the push rod 11 and a nut member 84 is threaded thereon. The valve body 19 is disposed to pass through the push rod 11 and is biased downwardly in the figure by the biasing force of the compression coil spring 23 through a spring bracket 86.

Accordingly, with the coil 6 being deenergized, the valve body 19 is maintained at the position shown in the figure to maintain the communication between the fuel inlet side passage 22b and the fuel outlet side passage

22a, with the coil 6 being energized, on the contrary, the armature 12 is attracted by the stator 4 to pull the push rod 11 upward in the figure so that the valve body 19 is pulled upwardly in the figure against the biasing force of the compression coil spring 23. Thus, the fuel inlet side passage 22b and the outlet side passage 22a are closed.

According to this embodiment also, because the position of the stator 4 is regulated in the stator axial direction at both the central part and the outer peripheral part, the similar advantages are provided as in each of the foregoing embodiments. Thus, no such drawbacks as the rising and displacement of the stator 4 (magnetic plates) occur.

The present invention may be embodied as follows in addition to the foregoing embodiments.

- (1) Although the support body 10 or the like is welded to the stator 4 by the laser-welding, these parts may be joined alternatively by arc welding or brazing. As long as the positions of the central part and the outer peripheral part of the stator are regulated, any other joint construction may be adopted.
- (2) Although the electromagnetic device 1 is applied to the normally open type electromagnetic valve, it may be applied to other devices.

Claims

1. An electromagnetic device comprising:

- a coil (6) electrically energized and deenergized;
- an armature (12) movable upon energization of the coil;
- a stator (4) supporting the coil and having a plurality of magnetic plates (8) shaped in a curved form and arranged in spiral form around a central axis thereof;
- a first position regulating member (10, 10a - 10h, W) for regulating an axial position of the magnetic plates at a central side of the stator; and
- a second position regulating member (13, 13a) for regulating an axial position of the magnetic plates at an outer peripheral side of the stator.

2. An electromagnetic device according to claim 1, wherein:

- the second position regulating member has a peripheral end part pressed to a magnetic pole face of the stator opposing the armature.

3. An electromagnetic device according to claim 1 or 2, wherein:

- the first position regulating member has an abutment part (10a) abutting an opposite face

sages 22a and 22b in the electromagnetic valve 1 cannot be interrupted completely, causing degradation of the performance of the electromagnetic device 1 used as a valve unit. According to the present embodiment, however, such a drawback will not occur because the displacement of the stator 4 is regulated. Thus, the performance of the electromagnetic device 1 used as a valve unit can be maintained.

(Second Embodiment)

In Fig. 7, the support body 10 as the first position regulating member is constructed by the disk part 10a and the cylindrical part 10b manufactured separately from each other. Although these disk part 10a and the cylindrical part 10b are separated into two parts, the two parts 10a and 10b are engaged into an integral body by respective stepped portions 10d and 10e, and the axial top end part of the cylindrical part 10b is welded to the stator 4 as indicated by W. At the time of welding by the laser welder, the top peripheral face part of the stator 4 and the top face of the ring 9 are pressed by the jig 25 which corresponds to the cap housing 13 of the electromagnetic device.

According to this embodiment, the following advantages are provided in addition to those provided in the first embodiment. That is, with the support body 10 being constructed by the disk part 10a and the cylindrical part 10b separately manufactured, material machining is eased and other workability in the various processes such as drilling is improved in comparison with the first embodiment in which the T-shaped support body 10 is integrally manufactured. Further, since the part to be chipped by the machining is reduced, the material cost is reduced and cost reduction is attained.

(Third Embodiment)

In Fig. 8, the support body 10 as the first position regulating member is constructed by the disk part 10a and the cylindrical part 10b manufactured separately as in the second embodiment. A stepped part 7a is formed on the top end of the through hole 7 of the stator 4 and a radially enlarged part 10f is formed on the top end of the cylindrical part 10b of the support body 10 in correspondence with the stepped part 7a. After the cylindrical part 10b is inserted into the through hole 7, the bottom end of the cylindrical part 10b and the bottom face of the disk part 10a are welded by the laser welder so that those parts 10a and 10b are integrated at the bottom as indicated W. At the time of welding by the laser welder, the top peripheral face part of the stator 4 and the top face of the ring 9 are pressed by the jig 25 which corresponds to the cap housing 13 of the electromagnetic device.

According to the present embodiment, in addition to the advantages provided in the first embodiment, advantages of machining simplification and cost reduc-

tion can be also provided as described in the second embodiment.

(Fourth Embodiment)

In Fig. 9, the support body 10 as the first position regulating member is constructed by the disk part 10a and the cylindrical part 10b manufactured separately as in the first and second embodiments. A tapered face 7b is formed on the top end of the through hole 7 of the stator 4 and a conical part 10g is formed on the top end of the cylindrical part 10b of the support body 10 in correspondence with the tapered face 7b. With the cylindrical part 10b being inserted into the through hole 7, the bottom end of the cylindrical part 10b and the bottom face of the disk part 10a are welded by the laser welder so that those parts 10a and 10b are integrated at the welded part indicated by W.

According to the present embodiment, in addition to the advantages of the first embodiment, advantages of machining simplification and cost reduction can be also provided as described in the second embodiment.

(Fifth Embodiment)

In Fig. 10(a), the support body 33 as the first position regulating member is constructed by a bottom part 10a formed in a generally cross-shape and a cylindrical part 10b raised vertically from the central part of the bottom part 10a. As shown in Fig. 10(b), the bottom part 10a may be formed in an elongated plate shape. The cylindrical part 10b of the support body 10 is inserted from the underside of the stator 4 and the top end of the cylindrical part 10b is welded as in the first embodiment. In this embodiment, the bottom part 10a which abuts the bottom face of the stator 4 may be changed to any shape as desired. It may be changed to three lateral extensions or may be formed in a polygonal shape.

In this embodiment, the bottom part 10a and the cylindrical part 10b may be manufactured integrally or separately. As described in each of the foregoing embodiments, the support body 10 may be constructed by welding two separate members.

(Sixth Embodiment)

In Fig. 11, The support body 10 as the first position regulating member is formed in the disk shape and assembled to abut the bottom face of the stator 4. The support body 10 is formed at the central part thereof a hole 10h having the same diameter as the through hole 7 of the stator 4. A bushing 62 is fitted in the through hole 7 of the stator 4 and the ring 9 is fitted around the outer periphery of the stator 4. The boundary between the through hole 7 and the hole 61a is welded by the laser welder as indicated by W with the bottom face of the stator 4 and the support body 10 being in contact with each other so that these members 4 and 10 are

and the top peripheral end face of the stator and the ring 9 are pressed downward via the cylindrical part 13a of the cap housing 13.

Signal input terminals 15 are fixed in the cap housing 13 by resin molding to receive electric signals supplied from the outside. The coil 6 is electrically connected to the signal input terminals 15 through lead wires not shown.

A valve housing 18 is assembled through a plate 17 at the bottom part of the solenoid housing 2. A valve body 19 is disposed in the valve housing 18 to open and close a fuel passage. The valve housing 18 is formed a slide hole 20 to hold the valve body 19 slidably. The slide hole 20 is in communication with a high pressure fuel chamber 21 formed annularly. Fuel passages 22a and 22b are formed in the valve housing 18 in communication with the high pressure fuel chamber 21. The valve body 19 is coupled with the bottom end of the push rod 11 and is normally biased to open (in the upper direction in the figure) by a compression coil spring 23.

It is to be noted that, because the valve body 19 is required to operate sufficiently fast in the electromagnetic valve 1, an upper chamber Q1 and a lower chamber Q2 around the valve body 19 as well as an armature chamber Q3 are maintained under the same pressure (fuel feed pressure supplied to a fuel injection pump, for instance) so that fast response characteristics of the valve body 19 is assured.

The stator assembly 3 is assembled as shown in Figs. 5 and 6 (the bottom face of the support body 10 is shown as a flat face in each figure for brevity). As shown in Fig. 5, the ring 9 is fitted around the radial outer periphery of the stator 4 and the support body 10 is fitted with the through hole 7 of the stator 4 from the underside. The coil 6 is molded in the coil insertion groove 5 of the stator 4. With an annular jig 25 being kept pressed on the top peripheral face part of the stator 4 and the top face of the ring 9, the top face of the cylindrical part 10b of the support body 10 and the inner peripheral faces (all end faces of the magnetic plates 8 exposed in the through hole 7) of the stator 4 are laser-welded to each other at welding part W1. In this instance, the jig 25 is used in place of the cap housing 13 shown in Fig. 1. By the laser-welding, all the magnetic plates 8 forming the stator 4 are welded to the support body 10.

After the completion of welding the stator 4 and the support body 10 by the laser-welding, an integral body of the push rod 11 and the armature 12 is inserted into the hole 10c of the support body 10 from the upperside so that the magnetic pole faces of the armature 12 and the stator 4 face each other.

The electromagnetic device 1 shown in Fig. 1 operates as follows. As long as the coil 6 is in the deenergized condition (shown in the figure), a certain predetermined air gap is provided between the top face of the stator 4 and the bottom face of the armature 12, and the valve body 19 coupled to the bottom part of the

push rod 11 is maintained at the predetermined open position. At this time, the top part of the armature 12 abuts a stopper, not shown, so that the valve open position of the valve body 19 is maintained. Thus, the fuel passages 22a and 22b are kept in communication with each other through the high pressure fuel chamber 21.

When the electric signal is applied to the signal input terminals 15 from the outside to energize the coil 6, the armature 12 is attracted toward the stator 4 and the air gap between the top face of the stator 4 and the bottom face of the armature 12 is reduced. The valve body 19 moves to the valve closure position in response to the movement of the armature 12 so that the communication between the fuel passages 22a and 22b are interrupted. At the time of energization of the coil 6, the stator 4 (magnetic plates 8) receives in the upward direction a pulling force resulting from the attraction between the stator 4 and the armature 12. The stator 4, however, does not rise nor is displaced, because the radially outer peripheral part of the stator 4 is pressed downward by the cap housing 13 and the central part of the stator 4 is fixedly supported by the cylindrical part 10b of the support body 10.

In addition to attaining regulation of the displacement of the stator 4, the present embodiment attains other advantages as follows.

(a) The locking nut 14 is threaded into the top end part of the solenoid housing 2 so that the cap housing 13 is pressed downwardly (toward the bottom in Fig. 1) by tightening. As a result, the peripheral part of the stator 4 can be fixedly supported simply but assuredly.

(b) The ring 9 is assembled around the outer periphery of the stator 4. Therefore, the stator 4 (magnetic plates 8) constructed by spiral stacking is prevented from breaking its generally cylindrical shape in the direction of outer periphery.

By these advantages (a) and (b), both the central side and the outer peripheral side of the stator 4 are position-regulated in the stator axial direction. As a result, the rising of the magnetic plates 8 can be regulated over the entire range and hence the deformation of the stator 4 can be prevented assuredly.

(c) The stator 4 is constructed by stacking a number of magnetic plates 8 spirally. If silicon steel plates (directional type or nondirectional type) having a good soft magnetic characteristics are used, the stator 4 can have a high maximum magnetic flux density and a high attraction force.

(d) Because the displacement of the stator can be regulated as described above, the performance of the electromagnetic device 1 with the stator 4 can be improved. That is, the air gap between the magnetic pole faces of the armature 12 and the stator 4 and the lift of the valve body 19 reduces responsively, when the stator 4 is displaced. In this instance, the communication between the fuel pas-

Fig. 6 is a cross sectional view showing the assembling process of the stator assembly;

Fig. 7 is a cross sectional view showing a construction of a stator assembly according to a second embodiment;

Fig. 8 is a cross sectional view showing a construction of a stator assembly according to a third embodiment;

Fig. 9 is a cross sectional view showing a construction of a stator assembly according to a fourth embodiment;

Fig. 10 is a perspective view showing a shape of a support body according to a fifth embodiment;

Fig. 11 is a cross sectional view showing a construction of a stator assembly according to a sixth embodiment;

Fig. 12 is a cross sectional view showing the construction of the stator assembly according to the sixth embodiment;

Fig. 13 is a cross sectional view showing an electromagnetic device according to a seventh embodiment;

Fig. 14 is a cross sectional view showing a conventional construction of a stator assembly;

Fig. 15 is a cross sectional view showing another conventional construction of a stator; and

Figs. 16(a) and 16(b) are a plan view and a cross sectional view showing the another conventional construction of the stator assembly shown in Fig. 15.

DETAILED DESCRIPTION OF THE PRESENTLY PREFERRED EMBODIMENT

The present invention is described in detail with reference to the accompanying drawings in which the same reference numerals are used to designate the same or like parts throughout the various embodiments.

(First Embodiment)

In the first embodiment shown in Fig. 1, an electromagnetic device 1 is used as an electromagnetically-operated fuel spill valve for fuel injection pump of a diesel engine so that the valve operates as a normally-open type valve. That is, during the normal operation in which a solenoid coil is deenergized, a valve body is kept to open a fuel passage by a biasing force of a biasing spring. With the solenoid coil being energized, the valve body moves against the biasing force of the biasing member to close the fuel passage.

In the electromagnetic device 1, a solenoid housing 2 is shaped generally cylindrically and is formed a thread 2a at the bottom outer periphery thereof for attaching the electromagnetic valve to a fuel injection pump not shown. A stator assembly 3 is fitted inside the solenoid housing 2. The stator assembly 3 has a solenoid stator (simply referred to as stator hereunder) 4. The stator 4 is formed an annular coil insertion groove 5

opening upwardly in the figure so that a coil 6 is wound in the insertion groove 5. The stator 4 is also formed a through hole 7 passing axially centrally (in up-down direction in the figure).

As shown in Figs. 2, the stator 4 has a stacked construction of a number of magnetic plates 8. As shown in Fig. 3, a silicon steel plate of uniform thickness is used for the plate 8. The silicon steel plate 8 is press-punched to form a rectangular cut-out or recess 8a and is bent in a curved shape longitudinally. Each plate 8 is disposed spirally around the central axis of the stator 4 by the aid of a certain jig or the like and its outer periphery is fixed circularly so that the stator 4 is assembled generally cylindrically as shown in Fig. 2. By this assembling, the coil insertion groove 5 is formed by the recess 8a of the plate 8.

As shown in Fig. 1 further, a ring 9 is fitted around the outer periphery of the stator 4. At the time of fitting the stator 4 with the ring 9, the spirally formed stator 4 is press-inserted against the inner peripheral face of the ring 9.

A support body 10 is assembled with the stator 4 in such a manner to abut the bottom face and the through hole 7 of the stator 4. The support body 10 is generally in a T-shape in cross section, and has a circular disk part 10a having generally the same outer diameter as that of the stator 4 and a cylindrical part 10b extending upwardly from the central part of the disk part 10a. A hole 10c is formed centrally in the support body 10. As shown in Fig. 4, the cylindrical part 10b of the support body 10 is press-fitted into the through hole 7 of the stator 4. In press-fitting the support body 10, the ring 9 may be fitted around the stator 4 after the support body 10 has been press-fitted into the stator 4, or alternatively the support body 10 may be press-fitted with the stator 4 with the ring 9 fitted around the stator 4.

As shown in Fig. 1, the length of the cylindrical part 10b of the support body 10 is slightly shorter than the height (axial length) of the stator 4. The top end part of the cylindrical part 10b is fixed to the stator 4, i.e., to all the radially inner peripheral end of the magnetic plates 8a, by laser welding. The welded part is indicated by W in Fig. 1.

A push rod 11 is positioned in the hole 10c of the support body 10 axially slidably (in an up-down direction in the figure). An armature 12 is coupled with the top end of the push rod 11. The armature 12 is so arranged as to be attracted toward the top face (magnetic pole face) of the stator 4 by the magnetic force generated at the time of energization of the coil 6.

A cap housing 13 is mounted above the armature 12 in a manner to tightly abut the inner peripheral face of the solenoid housing 2. The cap housing 13 has an annular peripheral part 13a extending axially downwardly. The bottom face of the annular peripheral part 13a is in abutment with both the top peripheral end part of the stator 4 and the top end face of the ring 9. With a locking nut 14 threaded into the top end part of the solenoid housing 2, the cap housing 13 is fixed in position

Description

BACKGROUND OF THE INVENTION

1. Field of the Invention:

The present invention relates to an electromagnetic device which has a stator constructed by a plurality of spirally stacked magnetic plates.

2. Description of Related Art:

It is conventionally proposed by Japanese Laid-open Patent Publication No. 4-365305, for instance, to construct a solenoid stator for an electromagnetic device by stacking spirally a plurality of magnetic plates having a uniform plate thickness. This electromagnetic device is shown in Fig. 14. In this device, a coil 6 is wound in a coil insertion groove 6 of a stator 4 and a push rod 11 coupled with an armature 12 is disposed slidably movably in a through hole 7 formed at the central part of the stator 4. According to this construction, when the coil 6 is energized, the armature 6 is attracted toward the magnetic pole face (upper or top face in the figure) of the stator 4 so that a valve body (not shown) coupled with the bottom end of the push rod 45 opens and closes.

According to this conventional device, the stator 4 and the armature 12 are likely to attract each other by the magnetic force during the coil energization, causing such drawbacks as that the stator 4 rises and is displaced. That is, in the case of the stator constructed by stacking numerous magnetic plates spirally, the central part of the stator is not supported sufficiently and hence the central part tends to rise causing rising displacement. Such a rising of the stator central part causes the air gap provided between the stator and the armature to decrease, thus affecting the performance of the electromagnetic device or the like.

It is also proposed in Japanese Laid-open Patent Publication No. 3-125086 to regulate rising of a solenoid stator for an electromagnetic device by a stator support structure for an electromagnetic device. According to this structure, a stator is constructed by stacking E-shaped magnetic plates and pressing the peripheral end face of the stator by a support member. As shown in Fig. 15 in more detail, the stator 4 has thin magnetic plates 51 stacked at both right and left positions and a thick plate 52 disposed centrally so that the stator 4 is shaped in a generally cylindrical form as a whole. The plate 52 is formed a through hole 7 for insertion of a push rod.

This conventional device has, as shown in Figs. 16(a) and 16(b), a coil 6, armature 12 and the like with the stator 4. As shown in the figures, an annular support member 54 is mounted on the upper face of the stator 4 thereby to press the longitudinal end (both end parts of all the magnetic plates 51 and 52). Although the stator 4 and the armature 12 operate to attract each other dur-

ing energization of the coil 6 also in this construction, the stator 4 is regulated from being displaced by the support member 54 which presses the stator 4.

5 SUMMARY OF THE INVENTION

The present invention has an object of providing an electromagnetic device which has a solenoid stator comprised of a plurality of magnetic plates stacked spirally and regulated from displacement.

For attaining this object, a first position regulating member is provided for regulating an axial position of magnetic plates at the central side of a stator and a second position regulating member is provided for regulating an axial position of the magnetic plates at the outer peripheral side of the stator. The first and the second position regulating members cooperatively regulate both the central side and the outer peripheral side of the stator axially so that the magnetic plates are prevented from rising to assuredly prevent the deformation of the stator.

Preferably, the first position regulating member has an abutment part abutting an opposite face of a magnetic pole face opposing an armature and also a position regulating part for regulating, in a position from the abutment part to a through hole at the stator central part, the axial position of the magnetic plates. The position regulating part particularly regulates the rising of the magnetic plates at the inner end side thereby to prevent the deformation of the stator more assuredly.

Preferably, the first position regulating member is in abutment with an opposite face of a magnetic pole face opposing an armature and is welded to the magnetic plates within the through hole at the stator central part.

Preferably, the second position regulating member is in a ring shape and presses a peripheral end part relative to a magnetic pole face opposing an armature.

More preferably, the position regulating part has a cylindrical body or an axial body welded to an end face of the magnetic plates within the through hole of the stator, or the position regulating part has an engagement part engaged with an end face of the magnetic plates within the through hole of the stator.

45 BRIEF DESCRIPTION OF THE DRAWINGS

In the accompanying drawings:

Fig. 1 is a cross sectional view showing a construction of an electromagnetic device according to a first embodiment of the present invention;

Fig. 2 is a perspective view showing a construction of a stator used in the first embodiment;

Fig. 3 is a perspective view showing a shape of a magnetic plate used in the first embodiment;

Fig. 4 is a perspective view of the stator and a support body before assembling;

Fig. 5 is a cross sectional view showing assembling process of a stator assembly;